Access to Credit, Factor Allocation and Farm Productivity: Evidence From the CEE Transition Economies[1]

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Abstract

Drawing on a unique farm level panel data set with 37,409 observations and employing a matching estimator, this paper analyses how farm access to credit affects farm input allocation and farm efficiency in the CEE transition countries. We find that farms are asymmetrically credit constrained between inputs. The use of variable inputs and capital investment increases up to 2.3% and 29%, respectively, per 1000 EUR of additional credit. Our estimates suggest also that farm access to credit increases the total factor productivity up to 1.9% per 1000 EUR of additional credit, indicating that an improved access to credit results in adjusting the relative input intensities on farms. This finding is further supported by a negative effect of better access to credit on labour, suggesting that these two are substitutes. Interestingly, farms are found not to be credit constrained with respect to land.

Keywords: Access to credit, investment, factor allocation, productivity, transition countries.

JEL classification: D14, G21, Q12, P14.

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1. INTRODUCTION

The shortage of credit has been identified as a crucial factor determining farm performance and development. Budget constraint has been found to be an important factor limiting farms' use of inputs not only in developing countries but also in developed economies (Bhattacharyya and Kumbhakar 1997; Heltberg 1998; Lee and Chambers, 1986; Färe, Grosskopf and Lee, 1990; Blancard *et al*., 2006). Due to a series of transition-related problems this problem has been especially acute within the Central and Eastern European agricultural sector (Swinnen and Gow, 1999; OECD, 1999; OECD, 2001; Dries and Swinnen 2004).

The main focus of the emerging literature on agricultural credit in transition countries are determinants of farm access to credit (Bezemer, 2002; Davis et al., 2003; Petrick and Latruffe, 2003; Latruffe et al., 2008). Considerably less attention has been paid to the relationship between credit constraint and farms' behaviour such as farms' input choices and productivity. Notable exceptions include Dries and Swinnen (2004) or Latruffe (2005). The fact that there are only few studies looking at the relationship between a credit constraint and farms' behaviour can be explained by a lack of the necessary micro-data for addressing the identification and endogeneity issues. The complexity of imperfections of rural credit markets makes it extremely difficult to test which farms are credit constrained, by how much, and what impact this may have on farm behaviour. This is especially difficult with a cross-section regressions since the estimated correlations may reflect an omitted variable or reverse causation problems. We try to address these issues by taking advantage of an extensive Farm Accountancy Data Network (FADN) data set on transition countries as well as semi-parametric methods.

The objective of the paper is to analyse how farm production and input use (land, variable inputs, labour, and capital) is related to farm access to credit in the CEE transition countries. To our knowledge, the present paper is the first to exploit a harmonised farm-level data to investigate the importance of access to credit for farm performance in the whole CEE region. In contrast to the existing studies, which usually are for single countries, we use a harmonised farm level panel data set for eight CEE transition countries. This allows us to investigate the effect of access to credit not only in particular countries, but also in the region as a whole. This is important because, notwithstanding the country-specific issues, all transition countries faced a number of common problems related to local credit markets: from lack of skilled and experienced banking staff, lack of accountancy and bookkeeping system at farm level, and politically rather than economically motivated asset (re)distribution in the beginning of the 1990s, to farms' accumulated debts and incomplete property rights to land that reduced the suitability of land as collateral (Swinnen and Gow, 1999; OECD 1999; OECD, 2001).

The large size of the FADN data set has an additional advantage. It allows us to employ a semi-parametric estimator based on the propensity score matching (Rosenbaum and Rubin, 1983). Using more than 37,409 observations assures that the loss in efficiency of semi-parametric estimates, as compared to parametric ones, is not a problem. This is important for at least two reasons. First, applying a semi-parametric propensity score matching (PSM) estimator allows us to control for any heterogeneity in the relationship between farm performance and their observable characteristics (in particular access to credit). Second, matching estimators are robust in situations where farms having access to credit systematically differ from those that do not.

The conceptual framework of our study is based on Blancard *et al.* (2006). In our model the availability of credit is determined by several factors, as farms have various options how to access financial resources. First, financial resources are channelled to agricultural sector through vertical integration. The recent expansion of vertical integration and contracting were shown to be an important source of credit to farms in the CEE (Dries and Swinnen 2004; Gorton and White, 2007; Swinnen, 2007). Second, governments in many countries intervene in agricultural markets with agricultural support policies. Even though agricultural support measures may not be intended to directly improve farm access to credit, they may alleviate farms' budget constraint by increasing farms' cash flow and thus increasing their credit-worthiness (Ciaian and Swinnen, 2009). Moreover, the interaction of rural financial structures and government interventions may lead to input specific adjustments. For example, agricultural subsidies may increase short-run credit which is needed to finance variable inputs rather than long-run credit which is needed for fixed inputs (Ciaian and Swinnen, 2009). Third, in the presence of costly contract enforcement and asymmetric information, the collateral may represent an important instrument in securing farms' access to credit (Bester, 1985; Ghosh, Mookherjee, and Ray, 2000). The use of collateral for securing credit is in turn conditional on the functioning of rural land markets (Ciaian and Swinnen, 2009). Underdeveloped land markets limit the possibility to use land as collateral, which reduces farm access to credit affecting particularly the long-run possibilities to finance fixed input purchases. Finally, factors such as rural insurance markets and informal rural institutions directly or indirectly may affect farm credit, for example, by affecting, among others, the risk level of agricultural production, loan guarantee options, and income volatility.

The theoretical model offers two testable hypotheses for farm adjustments in input use and output supply. The first hypothesis says that with perfect credit markets the source of financing is irrelevant, hence a farm access to credit will neither affect farm input choices nor the level of farm output. Hence, we implicitly assume that farm input and productivity response to access to credit reflects a farm credit constraint. The second hypothesis says that a symmetric credit constraint affects the scale of input use, but not the relative input intensities, whereas an asymmetric credit constraint affects both the level of input use and the relative factor intensities.[5] A symmetric credit constraint does not affect the relative (shadow) prices of inputs. In effect, if farms face symmetric credit constraint on all inputs, improved access to credit increases the use of all inputs (Blancard *et al.*, 2006). On the other hand, an asymmetric credit constraint affects both the relative marginal value product of inputs as well as the scale of input use (Lee and Chambers, 1986; Färe, Grosskopf and Lee, 1990). As a result, it will affect both the level

[5] We distinguish between a short-run and long-run credit constraint. A symmetric credit constraint implies that there is no differentiation between credit rationing related to operational expenses and long-run investments. An asymmetric credit constraint instead, describes the situation where a farm is differently constrained in its access to a short-run and a long-run credit. Note that this results in differentiated farm access to variable and fixed inputs, respectively (see further).

of input use and the relative factor intensities. More credit constrained inputs will be substituted for less credit constrained inputs.

Our results have important policy implications, as in the CEE transition countries farms receive a substantial amount of support from the EU Common Agricultural Policy (CAP). First, farms are granted direct payments either per hectare or coupled to production. Second, farms receive investment support from the EU Rural Development Polices. Our study examines which farm inputs are particularly credit constrained, and hence indicates what kind of support measures might be particularly efficient for policy interventions for alleviating farm credit problems in the CEE transition economies.

The reminder of the paper is organised as follows. In section 2 we set out the theoretical framework, which identifies the likely impact of the short- and long-run credit constraints on farm behaviour and output. Section 3 outlines our econometric strategy, section 4 presents the data and variables' definition, whereas section 5 reports the estimation results. Finally, section 6 summarises and concludes.

2. THEORETICAL FRAMEWORK

2.1 Related literature

There are three approaches to study the credit constraint.[6] First, farm/household profit/utility maximisation models are extensively used to explain the observed patterns of farm/household behaviour in the presence of credit constraint (e.g. Lee and Chambers 1986; Färe, Grosskopf, and Lee 1990; Blancard et. al 2006; Feder 1985; Carter and Wiebe, 1990). The second strand of literature are investment models based on the Modigliani–Miller's theorem (Modigliani and Miller 1958), which says that investments and asset allocation is independent of the means of financing (debt or equity). These studies analyse how the results are affected if the Modigliani–Miller theorem is violated (e.g. Mishra, Moss and Erickson 2008). The third approach includes asymmetric information models. The risk and asymmetrical information may lead to adverse selection and moral hazard and may induce lenders to ration the amount of credit supplied to the

[6] For more details on credit rationing in agriculture see summary papers of Barry and Robinson (2001).

farm sector, giving rise to a liquidity or credit constraint and impacting farm behaviour (e.g. Carter, 1988).

In the present study we develop a farm profit maximisation model along the first approach. Below we briefly review the previous literature that we draw on in our theoretical framework. A notable early paper on the farm level effects of the credit constraint is Lee and Chambers (1986) who develop a theoretical farm profit maximisation model with farms facing constraints on funding short-run farm operating expenses. They consider a situation where farm's total expenditures on variable inputs are constrained by a predetermined level of expenditure. Testing the model on the US data, Lee and Chambers reject unconstrained farm profit maximisation behaviour, while expenditure-constrained profit maximisation could not be rejected.

Färe, Grosskopf, and Lee (1990) adopt a nonparametric alternative to the Lee and Chambers (1986) model. Similarly to Lee and Chambers, they compare the behaviour of farms with constrained expenditure on variable inputs with that of farms not being credit constrained. Specifically, Färe, Grosskopf, and Lee construct a deterministic frontier profit function with and without expenditure constraints using a linear programming approach. They apply the model to a sample of Californian rice farms. Their results indicate that 21% of farms face a binding credit constraint. The average profit loss of the expenditure-constrained farms was found to be around 8% of their unconstrained profit.

Blancard et. al (2006) extend the model of Lee and Chambers (1986) and Färe, Grosskopf, and Lee (1990) to differentiate credit constraints between short- and long-run. They assume that in the short-run only the expenditures on variable input are constrained, while in the long-run the expenditures on all (variable and fixed) inputs are constrained. They test the model predictions using a panel of French farmers for the Nord-Pas-de-Calais region. Blancard et. al find that in the short-run 67% of farms are credit constrained, while in the long-run almost all farms are credit constrained. The losses in profits due to credit constraint amount on average to 8% and 49% of profits in short- and long-run, respectively.

The farm model has also been employed to investigate, among others, the productivity effect of farm credit constraint (Bhattacharyya and Kumbhakar, 1997; Briggeman, Towe and Morehart, 2009), the productivity and farm size in developing countries (Feder 1985; Carter and Wiebe, 1990), the allocation of farm inputs (Bhattacharyya, Bhattacharyya and Kumbhakar, 1996) and distributional effects of agricultural support policies in the presence of credit constraint (Ciaian, Kancs and Swinnen, 2008; Ciaian and Swinnen, 2009). Except for the latter two studies however, the existing literature does not deal with the transition countries.

2.2 The model

We build the theoretical framework of the present study on the model of Blancard et. al (2006). Accordingly, we consider a representative profit-maximising farm with a possibility for input credit constraint. The constant return to scale production technology (*f(X,Y)*) of the representative farm is assumed to be a function of two inputs, *X* and *Y*. The representative farm's profits are given by $\Pi = pf(X,Y) - w_X X - w_Y Y$ where *p* is output price and w_i are input prices for *i* = *X*, *Y*.

Following Blancard et. al (2006), we model imperfect credit market by assuming that the credit constrained farm has C amount of credit available for financing input purchases.[7] The value of credit *C* is a predetermined level of expenditure, which cannot be exceeded when purchasing inputs:[8]

(1) $\alpha w_X X + \delta w_Y Y \leq C$

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[7] An important source of credit constraint can arise due to a time lag between agricultural production and payment for variable inputs throughout the season. For example, variable inputs are paid at the beginning of season whereas the revenue from the sale of production is collected after harvest at the end of the season (Feder, 1985; Carter and Wiebe, 1990; Ciaian and Swinnen, 2009). These characteristics of agricultural production require pre-financing of inputs.

[8] The evidence from the literature shows that farm characteristics (e.g. reputation, owned assets, profitability) are important determinants of farm credit (e.g. Benjamin and Phimister, 2002; Petrick and Latruffe, 2003; Latruffe, 2005; Briggeman, Towe and Morehart; 2009). For example, using microdata from Poland, Latruffe (2005) finds that farmers with more tangible assets and with more owned land were less credit constrained than others. Briggeman Towe and Morehart (2009) find for farm and non-farm sole proprietorships in US that the probability of being denied credit is reduced, among others, by net worth, income, price of assets, and subsidies.

where α and δ are dummy variables which distinguish farm credit constraint between inputs. If $\alpha = 1$ and $\delta = 1$, it implies a symmetric farm's credit constraint for both inputs. A farm may be more credit constrained with respect to some inputs compared to others, implying an asymmetry in credit constraint. For simplicity, we assume that the farm is credit constrained either with respect to input *X* ($\alpha = 1$ and $\delta = 0$) or with respect to input *Y* ($\alpha = 0$ and $\delta = 1$).

Farm maximises profits subject to credit constraint (1) according to LaGrangean:

(2) $$\Psi = pf(X, Y) - w_X X - w_Y Y - \lambda(\alpha w_X X + \delta w_Y Y - C)$$

where λ is the shadow price of credit constraint. The optimal conditions for a credit constrained farm are as follows:

(3) $$pf_X = (1 + \lambda\alpha)w_X$$

(4) $$pf_Y = (1 + \lambda\delta)w_Y$$

From equations (3) and (4) it follows that the marginal value product of both inputs is higher than the price of inputs in equilibrium if a farm is symmetrically credit constrained (i.e. if $\alpha = 1$, $\delta = 1$ and $\lambda > 0$): $pf_X > w_X$ and $pf_Y > w_Y$, respectively. A farm could potentially increase its profits by increasing input use but it cannot do so because of a binding credit constraint. If a farm is asymmetrically credit constrained for the input *X* (i.e. if $\alpha = 1$, $\delta = 0$ and $\lambda > 0$), then only the marginal value product of input *X* exceeds its price, while the marginal value product of input *Y* is equal to the own price: $pf_X > w_X$ and $pf_Y = w_Y$, respectively. Reversely, if a farm is asymmetrically constrained for input *Y* (i.e. if $\alpha = 0$, $\delta = 1$ and $\lambda > 0$), then it holds that $pf_X = w_X$ and $pf_Y > w_Y$. Finally, if the farm's credit constraint (1) is non-binding (i.e. if $\lambda = 0$), then in equilibrium the marginal value product of both inputs is equalised with their respective prices: $pf_X = w_X$ and $pf_Y = w_Y$.

2.3 The impact of credit constraint on production

To establish a reference for comparative statics, we first identify the equilibrium without credit constraint ($\lambda = 0$). This is illustrated in Figure 1. The vertical axis shows the quantity of input *Y*, whereas the horizontal axis shows the quantity of input *X*. The equilibrium farm use of inputs with non-binding credit *C* is determined at point D, i.e. where the relative marginal value product of inputs is equal to their relative market prices, $pf_X / pf_Y \big|_* = w_X / w_Y \big|_*$.[9] The equilibrium *D* is determined by the tangency between the isoquant *I* and the isocost curve *EE*. We assume that the output level given by the isoquant *I* represents the optimal farm output for the given input and output prices and with non-binding credit constraint. The size of credit is irrelevant in this case; the credit does not affect output level and farm input choices.

Asymmetric credit constraint

An asymmetric credit constraint binds one input: farm is credit constrained either with respect to input *X* ($\alpha = 1$, $\delta = 0$) or with respect to input *Y* ($\alpha = 0$, $\delta = 1$). Consider a reduction of available farm credit from *C* to C_1 ($C_1 < C$). We assume that C_1 makes the credit constraint (1) binding ($\lambda_1 > 0$). The binding credit C_1 affects one of the farm's equilibrium conditions (3) and (4), depending on which input is credit constrained. The asymmetric credit constraint increases the marginal value product of the constrained input above its market price, whereas for the unconstrained input the equality is not affected: $pf_i(C_1) - w_i \big|_{AS} > pf_j(C) - w_j \big|_{AS} = 0$, for *i*, *j* = *X*, *Y* (this follows from equations (3) and (4)), where input *i* is assumed to be credit constrained.

The impact of an asymmetric credit constraint can be decomposed into two effects: a scale effect and an input substitution effect. For example, consider a case when the input *X* is constrained ($\alpha = 1$, $\delta = 0$). Relative to a situation with a non-binding credit constraint, less credit reduces production scale. In Figure 1 it leads to a parallel shift of the isocost curve from *EE* to $E_{AS}'E_{AS}'$. This scale effect of an asymmetric credit constraint shifts the equilibrium from *D* to *F*, which is the tangent point between the isocost curve

[9] We define the notations $x\big|_*$, $x\big|_S$ and $x\big|_{AS}$ for equilibriums with non-binding, symmetric and asymmetric credit constraint, respectively.

$E_{AS}'E_{AS}'$ and the isoquant curve I_{AS}. The isoquant I_{AS} is below the no-credit constraint isoquant I implying a lower output with than without the binding (asymmetric) credit constraint. Note that the lower output scale reduces the use of both inputs ($X_{AS}^{'} < X^{*}$ and $Y_{AS}^{'} < Y^{*}$).

Second, equations (3) and (4) imply that $pf_i\ (C)/pf_j\ (C)\big|_* = w_i/w_j\big|_* < pf_i\ (C_1)/pf_j\ (C_1)\big|_{AS} = (1+\lambda_1)w_i/w_j\big|_{AS}$, where input i is assumed to be credit constrained. What follows, an asymmetric credit constraint changes the relative marginal value product of inputs by the shadow price of credit constrained input λ_1. In response to this, a farm substitutes the credit constrained input for a credit un-constrained input, because $pf_i\ (C)/pf_j\ (C)\big|_* < pf_i\ (C_1)/pf_j\ (C_1)\big|_{AS}$. In Figure 1, facing the credit constrain C_1, farm substitutes credit constrained input X for credit un-constrained input Y along isoquant curve I_{AS}. The isocost curve rotates from $E_{AS}'E_{AS}'$ to $E_{AS}''E_{AS}''$. The rotation of the isocost curve is determined by the adjustment of the relative input prices by shadow price λ_1 from $w_X/w_Y\big|_*$ to $(1+\lambda_1)w_X/w_Y\big|_{AS}$, respectively, where $w_X/w_Y\big|_* < (1+\lambda_1)w_X/w_Y\big|_{AS}$.[10] The rotation takes place until point B, which is determined by the credit constraint C_1 fixing the use of input X at X_{AS}^{C}.[11] Hence, the equilibrium shifts from point F to point B. The substitution effect changes the relative quantity of inputs for a given level of output. The use of credit constrained input X decreases ($X_{AS}^{C} < X_{AS}^{'}$), whereas the use of credit un-constrained input Y increases ($Y_{AS}^{*'} > Y_{AS}^{'}$) (Figure 1). What follows, as far as the constrained input X is concerned, the substitution effect works in the same direction as the scale effect. The opposite is true for the unconstrained input Y.

In summary, an asymmetric credit constraint reduces the equilibrium output, decreases the credit constrained input, and may increase or decrease the credit un-constrained

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[10] The slope of the isocost $E_{AS}'E_{AS}'$ is w_X/w_Y and the slope of the isocost $E_{AS}''E_{AS}''$ is $(1+\lambda_1)w_X/w_Y$.

[11] From equation (1) it follows that with the binding asymmetric credit constraint $X_{AS}^{C}\big|_{AS} = C_1/w_X$.

inputs. Farms expand the use of the credit un-constrained inputs, if the substitution effect is stronger than the scale effect. In the reverse case, if the substitution effect is smaller than the scale effect, then farms reduce the use of the credit un-constrained inputs.

Symmetric credit constraint

With symmetric credit constraint ($\alpha = 1$, $\delta = 1$), a farm is equally constrained with respect to both inputs. Totally differentiating the FOCs (3), (4) and credit constraint (1), and solving for $dX/dC|_S$, $dY/dC|_S$ and $df/dC|_S$ yields:

$$(5) \qquad \left.\frac{dX}{dC}\right|_S = \frac{\frac{1}{w_X}\left(pf_{YY} - pf_{XY}\frac{\delta w_Y}{w_X}\right)}{pf_{YY} + \left(pf_{XX}\frac{\delta w_Y}{w_X} - pf_{YX} - pf_{XY}\right)\frac{\delta w_Y}{w_X}} > 0$$

$$(6) \qquad \left.\frac{dY}{dC}\right|_S = \frac{\frac{1}{w_X}\left[pf_{XX}\frac{\delta w_Y}{w_X} - pf_{YX}\right]}{pf_{YY} + \left(pf_{XX}\frac{\delta w_Y}{w_X} - pf_{YX} - pf_{XY}\right)\frac{\delta w_Y}{w_X}} > 0$$

$$(7) \qquad \left.\frac{df}{dC}\right|_S = \frac{f_Y\left[pf_{XX}\frac{\delta w_Y}{w_X} - pf_{YX}\right] + f_X\left[pf_{YY} - pf_{XY}\frac{\delta w_Y}{w_X}\right]}{w_X\left[pf_{YY} + \left(pf_{XX}\frac{\delta w_Y}{w_X} - pf_{YX} - pf_{XY}\right)\frac{\delta w_Y}{w_X}\right]} > 0$$

A symmetric credit constraint reduces both farm inputs and output.[12] Consider in Figure 1 a reduction of the available credit to C_2 ($C_2 < C_1 < C$). Relative to a non-biding credit constraint, lower credit C_2 shifts the isocost curve from EE to $E_S E_S$. The new equilibrium is at the tangency point, A, between the isocost curve $E_S E_S$ and the isoquant I_S. A symmetric credit constraint does not affect the relative marginal value product of inputs:

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[12] Note that the necessary condition for a maximum for the farm profit function is that its second derivative must be negative ($\frac{\partial^2 \Pi}{\partial Y^2} < 0$): $\frac{\partial^2 \Pi}{\partial Y^2} = pf_{YY} + \left(pf_{XX}\frac{\delta w_Y}{w_X} - pf_{YX} - pf_{XY}\right)\frac{\delta w_Y}{w_X} < 0$.

$$pf_i\ (C)\big/ pf_j\ (C)\Big|_* = w_i\big/w_j\Big|_* = pf_i\ (C_2)\big/ pf_j\ (C_2)\Big|_S = (1+\lambda_2)w_i\big/(1+\lambda_2)w_j\Big|_S = w_i\big/w_j\Big|_S .$$ [13]

As a result, the substitution between inputs will not occur. Only the scale effect will reduce farms output and input use. Compared to a situation without credit constraint (point *D*), farms use less of both inputs ($X_S^* < X^*$, $Y_S^* < Y^*$) and produce less output (given by the isoquant curve I_S).

The theoretical results of our model can be summarised into two hypotheses: (i) input allocation and farm output are not affected by farm access to credit, if farms are not credit constrained; (ii) in the presence of credit constraint, the alleviation of the constraint will result in an increase in the farm output whereas the impact on the scale of farm inputs use is ambiguous. The latter hypothesis can be further decomposed into three auxiliary sub-hypotheses: (iii) the alleviation of an asymmetric credit constraint will result in the increase of both the equilibrium output and the equilibrium use of the credit constrained inputs; (iv) the alleviation of an asymmetric credit constraint will result in the decrease of the equilibrium use of the credit un-constrained inputs, if the substitution effect is stronger than the scale effect, and vice versa; (v) the alleviation of a symmetric credit constraint will result in the increase of the scale of production and the equilibrium use of all inputs.

3. ECONOMETRIC SPECIFICATION

We test the theoretical hypothesis empirically for the eight CEE transition countries. This faces several complications. One of the key econometric problems when estimating the effect of credit is selection bias, because the assignment to treatment (access to credit) is non-random and depends on farm characteristics. Several approaches are proposed in the literature to overcome this difficulty. The Heckman sample selection model provides one solution (Petrick, 2004). Other approaches include the use of switching regressors (Feder et al., 1990; Carter and Olinto, 2003).

In this paper, we study the impact of farm access to credit on farm performance by means of matching methods, which serve as a nonparametric alternative to linear regressions.

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[13] In Figure 1 this implies that the initial isocost curve *EE* is parallel with the isocost curve $E_S E_S$.

More precisely, we employ the propensity score matching estimator proposed by Rosenbaum and Rubin (1983) and further developed by Heckman et al. (1997, 1998).

The main purpose of the matching method is to mimic a controlled experiment where the treated group is constructed among the non-treated. In the context of the present study, matching estimators have two main advantages over standard estimators. First, it does not impose any functional-form assumption on how the access to credit affects farm behaviour. Accordingly, we can allow for all types of heterogeneities and non-linearities in the effect of credit as long as they relate to observable characteristics. Second, it allows us to base our analysis only on comparisons between farms similar in terms of observable characteristics. By doing so we avoid the potential problem of drawing inferences from comparing very different farms, which are likely to bias linear regression results (see, e.g. Blundell and Costa Dias, 2009).

Despite these advantages, due to high data demand matching methods have been scarcely used in agricultural economics (few examples include Dabalen et al. 2004; Bento et al., 2007; Key and Roberts, 2008; Pufahl and Weiss, 2009). The popularity of matching methods for studying the impact of farm access to credit on farm performance is even lower (to our knowledge the only exemption is Briggeman, Towe and Morehart, 2009). An important advantage of the present study is the large size of the FADN farm level panel data, which allows us to employ the matching approach for studying the determinants and implications of rural credit constraints in the transition context.

Using the same notation as in the theoretical model, C denotes an indicator for farm having access to credit $(C=1)$ or no (limited) access to credit $(C=0)$. Let Q_{1i} be the potential performance of farm i with access to credit (i.e. exposed to the treatment) and Q_{0i} the potential performance of farm i wit no (limited) access to credit (i.e. not exposed to the treatment, control). Finally, denote a vector of observable covariates by Z. Then the expected casual effect of the treatment on farm i's performance and the parameter of our interest would be $\mathrm{E}(Q_{1i} - Q_{0i}|Z_i,C_i = 1)$. This is the 'average treatment on the treated' (ATT), which measures the effect of access to credit on outcome variable for those farms that actually used credit (e.g. to pre-finance the purchase of inputs) compared to what would have happened if they would not have relied on credit (or they would have relied on other sources of finance).

Given that we do not observe what would have happened if farms with credit would had been denied access to external funding (or vice versa), we construct an estimate of the counterfactual: $E(Q_{0i}|Z_i, C_i=1)$. As shown by Rosenbaum and Rubin (1983), comparing farms with similar probability of getting credit given the observables in Z is equivalent to comparing farms with similar values of Z. Accordingly, using a probit model a probability for each farm of getting credit (propensity score) is computed. Next, based on this propensity score, for each treated observation a counterfactual is estimated using the kernel matching procedure.[14] This allows us to compare each treated observation only with controls having similar values of observables in Z. To assure that the compared farms are not too different in terms of propensity score, we employ matching with calliper 0.01.

Note that the adopted matching procedure relies on two critical assumptions: first, the so called *selection on observables* assumption and second, the *common support* assumption. The former assumes that the propensity score is a balancing function, i.e. conditional on Z, without access to credit the treated farms would behave in the same way as the control farms.[15] The latter assumes that the propensity score is bounded between 0 and 1. Thanks to this, each treated observation has its counterpart among the controls. We discuss how do these assumptions hold in our case below, where we motivate our choice of covariates to be included in Z.

4. DATA AND VARIABLE CONSTRUCTION

The econometric model outlined in the previous section requires data on farm credit,

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[14] 1 to 1 matching estimator was also used. However, although the matching performed somewhat worse in terms of reducing the differences in distribution of observable covariates among treated and non-treated farms, the main results remained unaffected and therefore, they are not reported here but may be obtained by request.

[15] As noted by Heckman *et al*. (1997), treated and controls may still differ even after conditioning on observables. This may be due to unobservable characteristics. One possible solution to mitigate this problem is to combine matching procedure with difference-in-differences method (see for instance, Pufahl and Weiss, 2009). However, given that our data spans only two years and does not include information on timing of granting credit, this method cannot be applied in our study.

variables determining farm access to credit and outcome variables capturing farm behaviour. The main data source we use in the present study is the Farm Accountancy Data Network (FADN). It covers 37,409 farms in 8 transition countries.[16] The Appendix presents more details about the FADN data, including the sources for each variable.

In order to gain a detailed and robust view about the potential impact of access to credit on farm performance, we use six *outcome variables* for which we identify ATT. All of them are measured in EUR. Farm output is directly available in the FADN data (SE131). The same applies to the investment variable. which captures gross investment on fixed assets (SE516). Variable costs are calculated by summing up the total specific costs (SE281), total farming overheads (SE336), and wages paid (SE370). Labour and land use are directly available in the FADN data (SE010 and SE025, respectively). We normalise all cost variables – the gross investment, variable costs, land and labour – by output. Finally, based on the FADN data, we use the Total Factor Productivity estimates based on the Olley and Pakes (1996) estimator as the sixth outcome variable.

The *dependent variable* in the probit model – farm credit – is constructed from the FADN variable total farm loans (liabilities) (SE485), which we normalise by farm output (SE131). We use a dummy variable to determine whether or not the farm has the normalised liabilities greater than zero.[17] Note that we observe solely the farm usage of credit, but not the (potential) availability of getting credit (i.e. whether a farm is credit constraint or not), as information about the latter is not available in our data set. Nevertheless, testing the theoretical hypotheses derived above allows us also to indirectly investigate the impact of credit constraint. This is possible thanks to exploiting the relationship between farm access to credit and different inputs' use as well as investigating the relationship between farm access to credit and farm output.

As noted by Briggeman, Towe and Morehart (2009), the impact of credit constraint may be non-linear. In order to estimate the impact of different levels of credit constraints, in

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[16] At the end, after cleaning the data from outliers, our analysis is based on 34,169 observations.

[17] We also investigate other specifications where the treatment is defined over the relative size of credit. In that case a dummy dependent variable equals to one if the normalised liabilities are greater than a given threshold (see further).

addition to identifying the treatment effect of using credit, we also estimate the treatment effect of heterogeneous intensities of credit reliance. For this purpose, we split the whole sample into 8 credit groups.[18] Group 1 contains farms with zero credit.[19] Group 2 contains farms with small credits, up to 10% of output. Groups from 3 to 7 contain farms with gradually increasing credit-output ratio ranging from 11% to 100% of output. Finally, group 8 represents farms with the largest loans (over 100% of the output). Table 1 presents our sample broken down by these credit size classes. The matching is done to obtain the following comparisons: group 2 vs group 1, group 3 vs group 2, group 4 vs group 3, group 5 vs group 4, group 6 vs group 5, group 7 vs group 6, and group 8 vs group 7.

TABLE 1 ABOUT HERE

As regards the choice of *covariates* that enter the estimation of the propensity score, it is crucial for several reasons (Blundell and Costa Dias, 2009). First, any omitted variable uncorrelated with *Z* that affects both the access to credit and its impact on farm behaviour may result in violating the *selection on observables* assumption. Second, including too many covariates may lead to a situation, where the *common support* assumption would not hold, since we will predict the treatment status too well. In order to trade off these two opposing concerns, we decided to select a limited number of covariates. Although such decision is always arbitrary, we believe to capture the main factors that would affect both the access to credit and farm behaviour (our outcome variables). According to the theoretical framework and the existing literature, we include the following covariates.

The first covariate in matrix *Z* is *subsidies*, which captures differences in farms' liquidity.

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[18] The division of farms into these 8 groups was done so as to satisfy the condition that the number of treated observations should be smaller than the number of controls. We have also tested the model for more than 8 farm groups. The results are consistent with those reported in the paper. However, the statistical power decreases, because the number of observations per group is lower thus reducing the model's predictability. The matching estimator requires relatively large number of observations, as each treated needs to have its counterfactual among the non-treated. Moreover, note that imposing the common support assumption is likely to result in dropping some observations for which the treatment status is predicted too well (Blundell and Costa Dias, 2009). This in turn, may render using matching procedure with a small sample rather difficult. In that case the loss of efficiency of the estimates (as compared to the parametric ones) may be non-negligible.

[19] Note that this does not imply that farms in this group were denied credit.

The subsidy variable is directly available in the FADN data (SE605) and measures all payments that farms may get on number of accounts. Following the existing literature, we normalise the subsidy variable by output.

Second, there is a large variation in our sample in the use of own land and labour between farms. Some farms rent large share of the utilised land whereas others cultivate only own land. Similarly, some farms use mainly hired labour, whereas others rely only on family workforce. To control for this source of heterogeneity, in the probit regression we include two factor ownership variables: *share of land owned* and *share of hired labour*. The former measures the ratio of owned land in total land endowment. The latter represents the share of hired labour in the total farm labour.

Third, since farm access to credit often depends on farms' ability to provide collateral, we condition farm credit on the *total fixed owned assets*. This variable is constructed by subtracting long and medium-term loans (SE490) from the total fixed assets (SE441). As above, we normalise the total own fixed assets by farm output.

Moreover, according to Briggeman, Towe and Morehart (2009), it is reasonable to assume that farm access to credit and farms' investment decisions (input use) may be determined by its size and general economic performance. In order to control for this source of heterogeneity, we also include a covariate *economic size*, which represents the economic size of farms measured in European Size Units (ESU) (SE005).

In addition to the described explanatory variables, in the first stage regressions we also include *dummy variables* to control for time dimension, sector and geographical location. All dummy variables are directly available from the FADN data: time dummy (year), sector (A8) and region dummy (A2).[20]

Finally, findings of Bezemer (2002); Petrick and Latruffe (2003); and Davis et al., (2003) suggest that the effects of credit are heterogeneous across countries. For example,

[20] In addition, we experiment also with lagged debt asset ratio as an explanatory variable. Although it improved the prediction power of our first-stage probit models it did not affect the results of our second stage treatment effect estimations. Moreover, it limited our sample only to farms with observations for two points in time which had detrimental effect on balancing properties of our matching procedure. Therefore, for brevity reasons we do not report these results here.

countries with higher land fragmentation are particularly prone to suffer from the credit constraint problem. Therefore, in addition to pooled estimations (8 countries), we also examine each country separately (Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland).[21]

5. ESTIMATION RESULTS

5.1 Matching

The quality of the matching depends on the extent to which the propensity score is a truly balancing function. Table A1 in the Appendix provides an overview about the distribution of selected covariates across the treated and control farms for the pooled sample.[22] Three key points are worth to note. First, before imposing the *common support* assumption (columns (1) and (2)) the treated and control farms differ significantly for most variables used to calculate the propensity score (irrespectively of which credit size classes we compare). These differences are removed with matching (columns (3) and (4)) which should be recognised as a second important observation. Only in the comparison between credit size 2 and credit size 1 the variables assets fixed owned, economic size and a time dummy retain a different distribution in the treated and control farms. This suggests that these covariates should be included among the explanatory variables that we use for the propensity score estimation. With this caveat in mind, we conclude that matching of treated and non-treated farms performed well and is valid for meaningful comparisons.

Third, for the vast majority of probit regressions (not shown) the pseudo R^2 is relatively low (ranging from 0.08 to 0.15),[23] suggesting that the covariates used leave a lot of

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[21] Slovenia and Slovakia were dropped due to insufficient number of observations for given size classes.

[22] Due to a large number of comparisons made, results of tests showing how well did the propensity score as a balancing function for the country sub-samples are not reported here. However, they might be obtained from authors upon request. Balancing properties were fulfilled in 3 out of 7 cases for Latvia, 5 out of 7 cases for Czech Republic, Estonia and Lithuania and 6 out of 7 cases for Poland.

[23] This concerned especially regressions predicting transitions between groups of farms with credit-output ratio larger than zero. Somewhat better predictions were obtained for transitions between credit groups 2 and 1, i.e. between farms having no credit at all and farms having credit not exceeding 10% of the production value (pseudo R^2 ranging from 0.1 to 0.3 depending on (sub-)sample used).

residual variation unexplained. One may argue, therefore, that the included covariates do not accurately predict the state of being granted a (higher) credit. This is presumably due to the fact that our dataset does not contain any information about individual characteristics of farmers (e.g. age, education, having a successor etc.), informal institutions or social norms (e.g., relatives or friends between lenders and credit takers), which however are important for making the decisions about (not) granting a credit to a farm. However, the objective of this study is not to specify a statistical model explaining farm access to credit in the best possible way. Having probit regressions with large prediction power would lead to a much smaller number of treated farms meeting the common support assumption. This is especially important for country sub-samples, where the number of observations *per* credit size group is relatively small (sometimes around 200). Moreover, also other empirical studies employing matching estimators for studying farm access to credit report low pseudo R^2 (e.g. Briggeman, Towe and Morehart (2009) report pseudo R^2 equal to 0.31).

Bearing these limitations in mind, we conclude that the balancing property of our matching is both statistically and economically satisfactory and it is justifiable to estimate the treatment effect of farm access to credit according to the econometric strategy outlined above.

5.2 Pooled sample

Tables 2 and 3 report the results for the pooled sample in absolute values and in percentages, respectively. Each column refers to a different output variable. All estimators are based on kernel matching and the reported numbers should read as follows: positive (negative) numbers refer to increase (decrease) in output variable for farms in the treated group compared to farms in the control group[24]. For example, the results for investments shown in column 3 of Table 3 (Table 2) indicate that farms in credit class 2 have 29.04% more investments per 1000 EUR of additional credit (higher normalised investments by 0.086) than farms in credit class 1.

[24] To facilitate the reading of Tables 2-9, the treated group is indicated in bold.

TABLE 2 ABOUT HERE

Several conclusions can be drawn based on these results. First, no statistically significant impact of credit on the value of production was found (column 1). Although the results suggest that farm access to (higher) credit positively affects the value of production in all except the two highest credit-per-output groups, the precision of the obtained estimates is too low to render them significantly different from zero.[25] Second, the obtained results suggest that farm access to (higher) credit has a positive impact on the total factor productivity. The increase in the TFP between credit classes ranges between 0.07% and 1.87% per 1000 EUR of additional credit with the largest gain in productivity being for low level of credit (Table 3). This indicates a decrease in the marginal productivity per additional credit. This result is consistent with the estimates reported in column 3, suggesting that access to credit increases the level of relative investments, which should be recognised as a third important observation. The increase in investment is significant for most of the credit group comparisons ranging between 0.14% and 29.04% per 1000 EUR of additional credit (Table 3). Interestingly, no impact on the relative land endowments was found (column 4). Furthermore, our results suggest that credit has a positive effect on the use of variable inputs (between 0.01%, and 2.34% per 1000 EUR of additional credit, Table 3). Finally, a negative impact of access to credit on the use of labour was found (between -0.14%, and -1.64% per 1000 EUR of additional credit, Table 3). This can be explained by the fact that through credit farms mainly finance capital equipment, which usually is labour saving. The negative relationship between farm access to credit and labour use is reversed for the two highest credit/output ratio groups (by 0.02% per 1000 EUR of additional credit, Table 3). This indicates that labour is being substituted by capital up to a point, where more investment ultimately reduces such possibility.

It is important now to collate these findings with the theoretical hypotheses mentioned above. Recall that the model developed in section 2 predicts that in the presence of credit constraint, an access to external funding should result in positive impact on farm output

[25] However, given that semi-parametric methods trade off reduced bias due to specification error against less efficiency, this result is not that surprising.

and the scale of inputs' use. The exact adjustment pattern depends on whether the constraint is symmetric or not. Overall, the obtained results suggest that farms are asymmetrically credit constrained. Farms tend to be credit constrained with respect to investments and variable inputs, but credit unconstrained with respect to land and labour. For labour the results indicate that substitution effect tends to be stronger than the scale effect (particularly for low credit classes) leading to a substitution of labour for credit constrained investments and variable inputs. For land the substitution effect tends to offset the scale effect resulting in no impact of credit on land use. The change in the relative input intensities is further highlighted by the positive impact of an improved access to credit on farm productivity.

5.3 Country level analysis

In order to gain more country-specific insights, we examine how these patterns differ across the CEE transition countries. The obtained estimates of treatment effects based on country sub-samples are presented in Tables 4-9. Generally, country specific results complement our findings based on a pooled sample. First, we observe robust evidence on the positive and significant impact of access to credit on investment. Second, no single evidence was found that the credit constraint would influence farm's land use. This result again suggests that farms in the CEE are not credit constrained with respect to land. Third, except for the two groups with the highest credit-output ratio, farm access to credit has a negative impact on labour use. As noted above, this can be explained by the fact that through credit farms mainly finance capital equipment, which usually is labour saving. Fourth, an interesting pattern emerges with respect to farm productivity. The obtained estimates suggest a statistically significant increase in TFP in three our sample countries: Hungary, Lithuania and Poland. These results are interesting, because these three countries are those with the highest share of small individual farms. This, in turn, indicates that credit constraint might be more problematic for small individual farms compared to large corporate farms. Moreover, in these three countries a significantly positive impact of farm access to credit on output could be observed. Fifth, at the country level the pattern of credit's impact on variable inputs is much less clear than in the pooled sample, which might be due to sizeable cross-country differences in farm structure. On the one hand, for all countries having small credits, the use of variable inputs increases significantly. On the other hand, for other credit size groups the estimates are much less stable and statistically insignificant from zero.

TABLES 4-9 ABOUT HERE

In summary, the country level estimates are largely consistent with the pooled sample results. Farms tend to be asymmetrically credit constrained. The statistical significance level is smaller for the country level results than for pooled sample, as the sample size is considerably smaller.

5.4 Limitations

Although, the FADN data is the largest, most comprehensive and harmonised farm level data set for the whole EU, in the context of the present study it suffers from several issues. While it allows us to control for a number of determinants of farm access to credit, we are unable to include in our analysis three important aspects that may affect the availability of external funding, namely general institutional environment, contracting and rural informal lending mechanisms. In effect, our analysis may suffer from unobserved heterogeneity problem. There are however three points that seem to mitigate this concern. First, we include sectoral and geographical dummies to capture at least part of the effect of the abovementioned omitted variables. Second, it seems reasonable to assume that socio-economic characteristics tend to cluster across regions. This in turn, would suggest that unobserved differences between farms could correlate with observed differences. Third, as noted by Frölich (2006) and Blundell and Costa Dias (2009) matching can cope with endogeneity of Z as long as these covariates are not determined by the regressor of interest (in our case farm access to credit). Obviously, whether this is the case in practice is an empirical matter. It seems, however, reasonable to assume that in our case observable characteristics are not endogenously affected by farms' prospects about treatment.[26]

[26] Although the share of land owned, economic farm size or fixed owned assets surely depend on the level of external funding, it is less likely that farms would be able to adjust them to affect the future prospects of getting credit.

Not all alternative sources of pre-financing input use have been captured in the present study due unavailability of data on contracting and rural informal lending mechanism. Because loans are not the only source of financing to farms, some farms that report zero loans may actually not be credit constrained if they can obtain sufficient financing through other channels. For this reason, our estimates of the impact of the access to credit (credit constraint) on farm behaviour may be biased downward (upward) if farm access to loans is negatively (positively) correlated with farm access to other sources of finance. Our estimates are accurate, if loans and other sources of finance are uncorrelated with each other. The abovementioned caveats should be kept in mind while interpreting the presented results.

6. CONCLUSIONS

The present paper studies the impact of credit constraint on farm behaviour in the CEE transition countries. The theoretical model suggests that, in the presence of a binding credit constraint, an improved access to credit may lead to productivity increase, farm output and the use of inputs. With symmetric credit constraint, the alleviation of farm credit constraint increases the use of all inputs. However, if farms are asymmetrically credit constrained, then the improved access to credit may lead to substitution of credit-constrained inputs to credit-unconstrained inputs.

The empirical results for the CEE suggest that farms are credit constrained. Access to credit increases TFP up to 1.9% per 1000 EUR of additional credit. However, our estimates indicate that farms are asymmetrically credit constrained. Farms in the CEE are particularly credit constrained with respect to variable inputs and capital investments, as variable inputs and capital investments increase up to 2.3% and 29%, respectively, per 1000 EUR of additional credit. On the other hand, land and labour are not credit constrained. This could be due to the relatively high land abundance and high agricultural labour employment in the CEE transition countries, particularly in Poland, Slovenia and the Baltic states. An alternative explanation could be that farms are able to better cope with financing issues of land and labour compared to variable inputs and investments. Family farms use mainly own labour in production, which reduces the need for pre-financing. Family labour can address credit problem by postponing household consumption to a latter period, when the revenue from the production sales is collected (after the harvest at the end of the season). Similar holds for land. Farms can increase land use through rental markets. Rental markets are relatively important in transition countries with more than 50% of land being rented (Ciaian and Kancs, 2009). Additionally, in most cases rents are paid at the end of the season, which further reduces the pre-financing needs for land (Ciaian and Kancs, 2009). Furthermore, (own) land serves as a good collateral and therefore, this is an additional factor which may reduce farms' credit constraint on land.

An important factor, which may reduce farm capital constraint for variable inputs and investments, are CAP subsidies as well as vertical contracting with processors and/or traders. Even though both CAP subsidies and contracting have increased in recent years, our results indicate that they were unable to fully eliminate farm credit problems in the CEE transition economies. Investigating these two issues in more details may constitute a potentially fruitful line of research that would importantly extend the presented work.

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Figure 1. Credit constrained farm optimisation

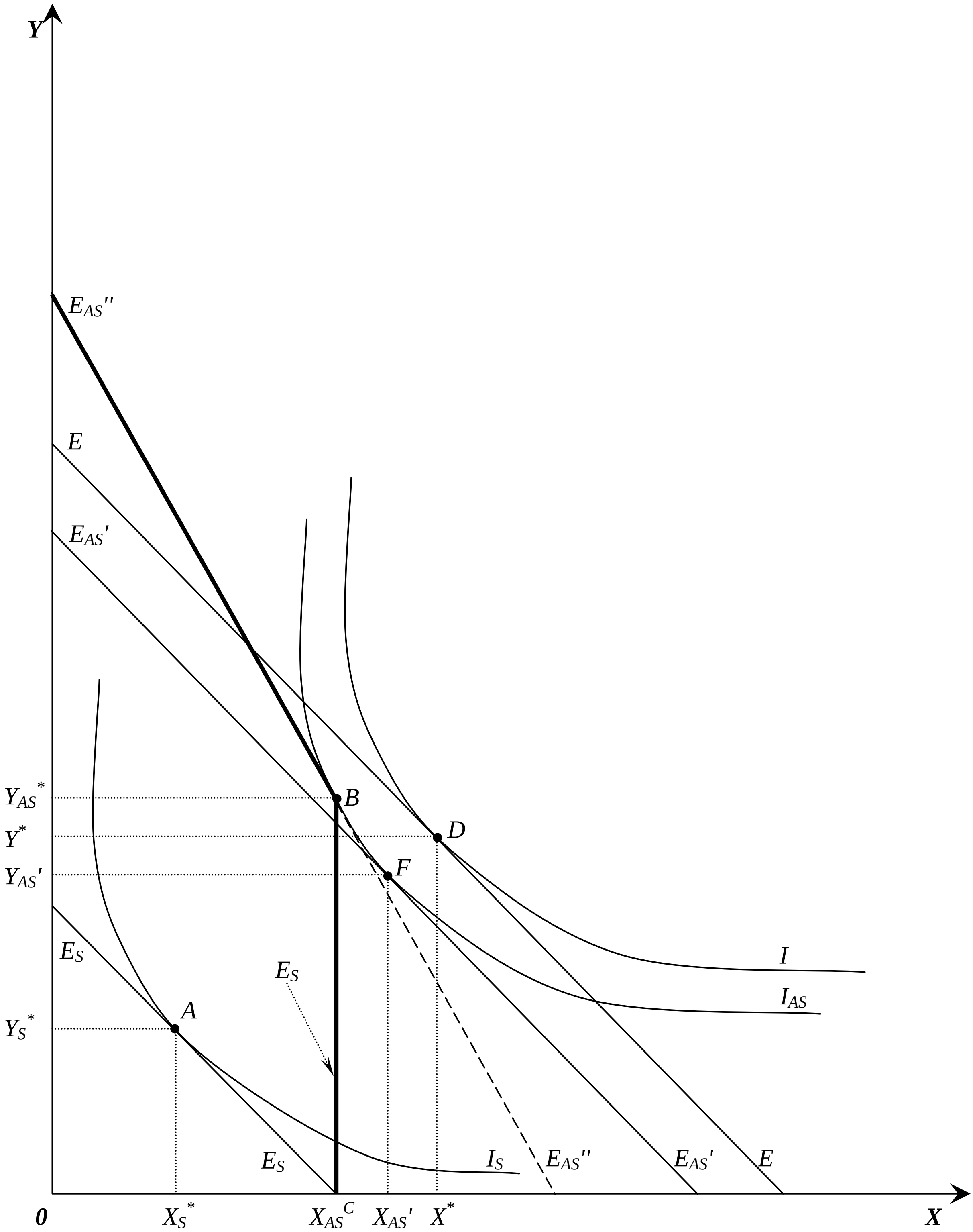

Table 1. Definition and summary of credit groups

Credit group	Credit / output, %	No observations
1	0	10832
2	0-10	4406
3	10-20	4147
4	20-30	3976
5	30-45	3853
6	45-70	3687
7	70-100	3377
8	>100	3131

Note: Group 1 captures farms with zero credit, group 8 represents farms with the largest credit/output ratio.
Source: Authors' calculations based on the FADN data.

Table 2. Credit and farm behaviour: Matching estimates of the effect of accessing credit on farm output and inputs – pooled sample

Credit classes: treated vs. control	Output (EUR) (1)	TFP (index) (2)	Investments (EUR per output) (3)	Land (Ha per output) (4)	Variable inputs (EUR per output) (5)	Labour (persons per output) (6)
2 vs. 1	5186	0.057 ***	0.086 ***	0.005	0.116 ***	-0.031 ***
t-stat	*1.18*	*9.30*	*26.97*	*0.59*	*24.36*	*-5.97*
3 vs. 2	5613	0.027 ***	0.006	-0.006	0.011 **	-0.006 *
t-stat	*1.06*	*5.41*	*1.40*	*-0.76*	*2.48*	*-1.82*
4 vs. 3	7131	0.035 ***	0.024 ***	-0.004	0.0005	-0.016 ***
t-stat	*1.15*	*6.55*	*4.98*	*-0.61*	*0.13*	*-4.91*
5 vs. 4	8586	0.031 ***	0.028 ***	-0.005	0.003	-0.010 ***
t-stat	*1.12*	*5.23*	*4.91*	*-0.72*	*0.68*	*-3.31*
6 vs. 5	3746	0.022 ***	0.059 ***	-0.007	0.005	-0.002
t-stat	*0.40*	*3.44*	*8.70*	*-0.87*	*1.13*	*-0.80*
7 vs. 6	-2864	0.009	0.059 ***	-0.002	0.010 *	0.001
t-stat	*-0.29*	*1.31*	*6.75*	*-0.27*	*1.84*	*0.37*
8 vs. 7	-7179	-0.014	0.128 ***	0.0009	0.016 **	0.009 **
t-stat	*-0.73*	*-1.53*	*9.56*	*0.09*	*2.53*	*2.30*

Source: Authors' estimations. ***, **, * denote 1%, 5% and 10% significance levels respectively

Table 3. Percentage change of productivity and use of inputs per 1000 EUR of additional credit – Pooled sample (%/EUR credit)

	Output (1)	TFP (2)	Investment (3)	Land (4)	Variable inputs (5)	Labour (6)
2 vs 1	1.87	1.87***	29.04***	0.12	2.34***	-1.64***
3 vs 2	0.36	0.31***	0.56	-0.05	0.05**	-0.20*
4 vs 3	0.03	0.25***	0.62***	0.00	0.00	-0.31***
5 vs 4	0.00	0.14***	0.41***	0.00	0.00	-0.14***
6 vs 5	0.0	0.07***	0.44***	-0.01	0.00	-0.01
7 vs 6	-0.03	0.02	0.21***	0.00	0.01*	0.02
8 vs 7	-0.03	0.00	0.14***	0.00	0.01**	0.02**

Source: Authors' estimations. ***, **, * denote 1%, 5% and 10% significance levels respectively

Table 4. Credit and farm behaviour: CZECH REPUBLIC

	Output	TFP	Investments	Land	Variable inputs	Labour
2 vs 1	7164	0.020	0.066 ***	-0.040	0.155 ***	-0.011
t-stat	*0.65*	*0.68*	*8.69*	*-0.79*	*5.56*	*-1.03*
3 vs 2	22660	-0.0001	0.030 *	-0.009	0.018	-0.011 **
t-stat	*0.89*	*-0.01*	*1.80*	*-0.30*	*0.95*	*-2.53*
4 vs 3	13932	0.003	0.003	-0.020	-0.0004	-0.004
t-stat	*0.20*	*0.12*	*0.13*	*-0.49*	*-0.01*	*-0.80*
5 vs 4	60068	0.023	0.029	.0144	0.005	-0.004
t-stat	*0.77*	*1.02*	*1.58*	*-0.50*	*0.22*	*-1.11*
6 vs 5	-33244	0.002	0.037 **	0.002	0.025	0.005 *
t-stat	*-0.44*	*0.11*	*1.98*	*0.13*	*1.35*	*1.65*
7 vs 6	-20499	0.012	0.031	-0.001	-0.013	-0.003
t-stat	*-0.31*	*0.70*	*1.30*	*-0.10*	*-0.80*	*-1.30*
8 vs 7	-21002	0.023	0.027	-0.006	0.025	0.007 **
t-stat	*-0.30*	*1.10*	*0.72*	*-0.29*	*1.16*	*2.14*

Source: Authors' estimations. ***, **, * denote 1%, 5% and 10% significance levels respectively

Table 5. Credit and farm behaviour: ESTONIA

	Output	TFP	Investments	Land	Variable inputs	Labour
2 vs 1	1642	0.013	0.074 ***	-0.005	0.153 ***	-0.015
t-stat	*0.53*	*0.30*	*6.26*	*-0.10*	*4.53*	*-0.51*
3 vs 2	-25352	0.005	0.002	0.015	0.017	0.005
t-stat	*-1.04*	*0.14*	*0.12*	*0.30*	*0.57*	*0.23*
4 vs 3	13698	0.022	0.060 **	0.015	-0.004	-0.009
t-stat	*0.33*	*0.52*	*2.44*	*0.29*	*-0.14*	*-0.41*
5 vs 4	10230	0.002	0.047 *	0.002	0.012	-0.004
t-stat	*0.26*	*0.06*	*1.78*	*0.05*	*0.51*	*-0.35*
6 vs 5	5929	0.068 *	0.071 **	0.0005	-0.033	0.009
t-stat	*0.19*	*1.83*	*2.02*	*0.01*	*-1.24*	*0.68*
7 vs 6	-275	-0.002	0.129 ***	-0.016	0.038	0.006
t-stat	*-0.01*	*-0.07*	*2.69*	*-0.38*	*1.45*	*0.36*
8 vs 7	-10496	-0.06	0.206 ***	0.020	0.017	0.015
t-stat	*-0.23*	*-1.18*	*2.57*	*0.39*	*0.48*	*0.62*

Source: Authors' estimations. ***, **, * denote 1%, 5% and 10% significance levels respectively

Table 6. Credit and farm behaviour: HUNGARY

	Output	TFP	Investments	Land	Variable inputs	Labour
2 vs 1	-104	0.074 ***	0.039	-0.007	0.086 ***	-0.011
t-stat	*-0.02*	*2.57*	*3.66*	*-0.15*	*3.13*	*-0.63*
3 vs 2	20825 **	0.091 ***	0.018	-0.004	-0.031 *	-0.010 *
t-stat	*2.36*	*4.58*	*1.40*	*-0.13*	*-1.83*	*-1.71*
4 vs 3	11824	0.042 **	0.005	-0.002	0.008	0.001
t-stat	*0.49*	*1.97*	*0.39*	*-0.08*	*0.47*	*0.29*
5 vs 4	10825	0.050 **	0.023	0.016	-0.023	-0.008
t-stat	*0.38*	*2.45*	*1.77*	*0.52*	*-1.32*	*-1.39*
6 vs 5	1308	0.0007	0.038	0.01	0.007	0.006
t-stat	*0.04*	*0.04*	*2.82*	*0.40*	*0.52*	*1.36*
7 vs 6	-13498	0.034 *	0.036	0.01	0.0006	-0.002
t-stat	*-0.44*	*1.86*	*2.09*	*0.41*	*0.05*	*-0.54*
8 vs 7	3189	-0.038 **	0.152	0.001	0.029 *	0.004
t-stat	*0.12*	*-1.97*	*5.80*	*0.06*	*1.89*	*0.83*

Source: Authors' estimations. ***, **, * denote 1%, 5% and 10% significance levels respectively

Table 7. Credit and farm behaviour: LITHUANIA

	Output	TFP	Investments	Land	Variableinputs	Labour
2 vs 1	9777 **	0.066 ***	0.123 ***	0.028	0.106 ***	-0.04 ***
t-stat	*2.08*	*3.41*	*9.30*	*0.95*	*7.40*	*-3.10*
3 vs 2	4611	0.036 *	0.031	0.008	0.0127	0.019 *
t-stat	*0.43*	*1.88*	*1.49*	*-0.33*	*0.84*	*-1.94*
4 vs 3	-5921	0.044 *	-0.004	0.002	-0.001	-0.009
t-stat	*-0.36*	*1.90*	*-0.19*	*0.07*	*-0.08*	*-1.12*
5 vs 4	1046	0.039	0.068 ***	0.001	0.004	-0.0001
t-stat	*0.06*	*1.51*	*2.65*	*0.05*	*0.29*	*-0.02*
6 vs 5	-5003	0.015	0.144 ***	0.0008	0.0127	0.001
t-stat	*-0.18*	*0.55*	*3.95*	*0.03*	*0.68*	*0.15*
7 vs 6	872	-0.012	0.092 **	-0.002	0.022	-0.014 *
t-stat	*0.04*	*-0.41*	*2.09*	*-0.09*	*1.12*	*-1.79*
8 vs 7	-9751	-0.055	0.327 ***	0.0007	0.039	0.023 *
t-stat	*-0.56*	*-1.42*	*5.00*	*0.02*	*1.62*	*1.66*

Source: Authors' estimations. ***, **, * denote 1%, 5% and 10% significance levels respectively

Table 8. Credit and farm behaviour: LATVIA

	Output		Tfp	Investments		Land	Variable inputs	Labour
2 vs 1	10385	***	0.017	0.128	***	0.021	0.141	-0.026
t-stat	*3.16*		*0.46*	*7.91*		*0.52*	*5.45*	*-0.86*
3 vs 2	-12669		0.035	0.052		0.001	-0.012	-0.020
t-stat	*-0.48*		*1.00*	*1.58*		*0.03*	*-0.47*	*-1.01*
4 vs 3	23078		0.028	0.007		0.0009	-0.018	-0.026
t-stat	*0.55*		*0.76*	*0.18*		*0.02*	*-0.70*	*-1.42*
5 vs 4	10145		0.014	0.021		-0.023	-0.003	-0.002
t-stat	*0.23*		*0.45*	*0.58*		*-0.54*	*-0.13*	*-0.16*
6 vs 5	-10943		-0.001	0.080	**	-0.014	0.017	-0.015
t-stat	*-0.27*		*-0.05*	*2.10*		*-0.36*	*0.80*	*-0.92*
7 vs 6	-51271		-0.035	0.151	***	-0.005	0.004	0.002
t-stat	*-1.01*		*-0.95*	*3.48*		*-0.15*	*0.18*	*0.18*
8 vs 7	19598		0.013	0.271	***	0.015	0.025	-0.006
t-stat	*0.57*		*0.30*	*3.95*		*0.34*	*0.89*	*-0.48*

Source: Authors' estimations. ***, **, * denote 1%, 5% and 10% significance levels respectively

Table 9. Credit and farm behaviour: POLAND

	Output		TFP		Investments		Land	Variable inputs		Labour	
2 vs 1	9492	***	0.066	***	0.066	***	0.0001	0.097	***	-0.035	***
t-stat	*5.47*		*13.55*		*19.90*		*0.02*	*27.56*		*-8.12*	
3 vs 2	2419		0.025	***	-0.001		-0.005	0.014	***	-0.003	
t-stat	*1.10*		*4.52*		*-0.34*		*-0.79*	*3.48*		*-0.74*	
4 vs 3	4648	*	0.038	***	0.024	***	0.001	-0.001		0.015	***
t-stat	*1.70*		*6.61*		*4.35*		*-0.21*	*-0.32*		*-3.70*	
5 vs 4	-133		0.035	***	0.024	***	-0.002	0.0006		-0.009	**
t-stat	*-0.04*		*5.25*		*3.63*		*-0.31*	*0.15*		*-2.48*	
6 vs 5	4190		0.033	***	0.057	***	-0.002	-0.003		-0.003	
t-stat	*1.12*		*4.43*		*6.73*		*-0.34*	*-0.68*		*-0.85*	
7 vs 6	-1565		0.015	*	0.055	***	-0.0005	0.009	*	0.003	
t-stat	*-0.40*		*1.75*		*4.91*		*-0.06*	*1.72*		*0.80*	
8 vs 7	-5619		-0.001		0.114	***	0.005	0.007		0.016	***
t-stat	*-1.62*		*-0.12*		*6.46*		*0.50*	*1.08*		*2.78*	

Source: Authors' estimations. ***, **, * denote 1%, 5% and 10% significance levels respectively

APPENDIX

Data

The main source of data we use in the empirical analysis comes from the Farm Accountancy Data Network (FADN) compiled and maintained by the European Commission. The FADN is a European system of sample surveys that take place each year and collect structural and accountancy data on the farms. In total there is information about 150 variables on farm structure and yield, output, costs, subsidies and taxes, income, balance sheet, and financial indicators. The yearly FADN sample covers approximately 18,700 agricultural farms in the eight NMS. In 2004 they represented a population of almost 1,000,000 farms in the seven NMS, covering approximately 90% of the total utilised agricultural area and accounting for more than 90% of the total agricultural production. The aggregate FADN data are publicly available. However, farm-level data are confidential and, for the purposes of this study, accessed under a special agreement.

To our knowledge, the FADN is the only source of micro-economic data that is harmonised (the bookkeeping principles are the same across all EU Member States) and is representative of the commercial agricultural holdings in the EU. Holdings are selected to take part in the survey on the basis of sampling plans established at the level of each region in the EU. The survey does not, however, cover all the agricultural holdings in the Union (universe defined by Community surveys on the structure of agricultural holdings), but only those which are of a size allowing them to rank as commercial holdings.

In the present study we use a sub-sample, which covers the eight NMS from the CEE. From the FADN data for two years (2004 and 2005) we create a panel of farming operations. For each year the FADN contains information of approximately 18,700 farms. Although, the total number of farms is roughly equal over the two years, this masks a great deal of turnover. The unbalanced panel contains 37,409 observations.

Table A1. Means of selected covariates across treated and control farms (pooled sample).

	Credit classes: treated vs. control 2 vs. 1				*Credit classes: treated vs. control 3 vs. 2*				*Credit classes: treated vs. control 4 vs. 3*			
	Before matching		***After matching***		***Before matching***		***After matching***		***Before matching***		***After matching***	
	(1)	**(2)**	**(3)**	**(4)**	**(1)**	**(2)**	**(3)**	**(4)**	**(1)**	**(2)**	**(3)**	**(4)**
	Treated	***Control***	***Treated***	***Control***	***Treated***	***Control***	***Treated***	***Control***	***Treated***	***Control***	***Treated***	***Control***
Land owned	0.629	0.771 [a]	0.629	0.623	0.678	0.628 [a]	0.679	0.685	0.660	0.678 [a]	0.661	0.666
Asset fixed owned	2.598	3.714 [a]	2.599	2.515 [a]	2.722	2.599 [a]	2.723	2.713	2.605	2.722 [a]	2.609	2.616
Subsidies	0.181	0.214 [a]	0.181	0.178	0.176	0.181 [a]	0.176	0.171	0.178	0.176	0.178	0.176
Labour hired	0.138	0.074 [a]	0.137	0.145	0.163	0.138 [a]	0.161	0.152	0.201	0.163 [a]	0.200	0.192
Farm size	32.304	17.226 [a]	32.167	37.037 [a]	39.796	32.520 [a]	37.727	35.228	47.962	39.796 [a]	47.513	45.393
Time dummy	1.446	1.541 [a]	1.446	1.406 [a]	1.458	1.446	1.458	1.450	1.482	1.458 [a]	1.483	1.478

	Credit classes: treated vs. control 5 vs. 4				**Credit classes: treated vs. control 6 vs. 5**				**Credit classes: treated vs. control 7 vs. 6**			
	Before matching		**After matching**		**Before matching**		**After matching**		**Before matching**		**After matching**	
	(1)	**(2)**	**(3)**	**(4)**	**(1)**	**(2)**	**(3)**	**(4)**	**(1)**	**(2)**	**(3)**	**(4)**
	Treated	***Control***	***Treated***	***Control***	***Treated***	***Control***	***Treated***	***Control***	***Treated***	***Control***	***Treated***	***Control***
Land owned	0.635	0.660 [a]	0.635	0.641	0.601	0.636 [a]	0.602	0.609	0.584	0.601	0.585	0.588
Asset fixed owned	2.429	2.605 [a]	2.430	2.438	2.349	2.423	2.353	2.366	2.339	2.349	2.343	2.350
Subsidies	0.181	0.178	0.181	0.179	0.192	0.181 [a]	0.192	0.188	0.212	0.192 [a]	0.211	0.208
Labour hired	0.240	0.201 [a]	0.239	0.232	0.271	0.239 [a]	0.270	0.261	0.292	0.271 [a]	0.292	0.286
Farm size	63.85	47.962 [a]	63.026	59.746	76.059	63.612 [a]	75.862	72.884	76.888	76.068	77.010	76.283
Time dummy	1.489	1.482	1.489	1.490	1.496	1.489	1.495	1.498	1.512	1.496	1.510	1.508

	Credit classes: treated vs. control 8 vs. 7			
	Before matching		***After matching***	
	(1)	**(2)**	**(3)**	**(4)**
	Treated	***Control***	***Treated***	***Control***
Land owned	0.598	0.585	0.600	0.599
Asset fixed owned	2.693	2.341 [a]	2.660	2.652
Subsidies	0.257	0.211 [a]	0.254	0.254
Labour hired	0.295	0.292	0.292	0.289
Farm size	59.559	76.978 [a]	59.946	59.58
Time dummy	1.528	1.511	1.528	1.530

[a]Significantly different means between observations from the potential (selected) treatment group and from the potential (selected) control group in a t-test for equality of means at the 5 per cent level.